Missouri Department of Natural Resources

Biological Assessment

Troublesome Creek
Marion County, Missouri

2004-2005

Prepared for:
Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Control Branch

Prepared by:
Missouri Department of Natural Resources
Field Services Division
Environmental Services Program
Water Quality Monitoring Section

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1.0 Introduction

Troublesome Creek originates approximately two miles north of Edina and flows in a southeasterly direction through Knox, Lewis, and Marion counties in northeast Missouri (Figure 1). Troublesome Creek ends in a confluence with the South Fabius River in Marion County, approximately one mile south of Hester, Missouri. Hester is approximately 12 miles northwest of Palmyra, Missouri. The Troublesome Creek watershed covers approximately 148 square miles, with a 46-mile long channel (Funk 1968).

The morphology of Troublesome Creek changes significantly from headwater to the confluence with South Fabius River (SCS 1977). The upper three-quarters of the stream flows through clay loess or glacial-till soils, which create deep, narrow stable channels with substrates of sand and clay. The lower one-quarter, which includes the study area, is characterized by cherty-limestone bedrock formations with cobble and gravel substrates. Only about ten percent of Troublesome Creek is channelized, mainly near bridge crossings. A recent Illinois publication (DeWalt et al. 2005) identifies channelization and channel maintenance as the most important factor degrading Illinois streams, on a small-scale.

Troublesome Creek is considered a class "P" stream, which maintains flow through drought periods and has beneficial use designations for livestock and wildlife watering (**LWW**); protection of warm water aquatic life and human health-fish consumption (**AQL**); and drinking water supply (**DWS**) (MDNR 2000).

1.1 Justification

The Troublesome Creek, Marion County study was conducted at the request of the Missouri Department of Natural Resources (**MDNR**), Water Protection Program (**WPP**), Water Pollution Control Branch (**WPCB**). Three and one half miles in Marion County are on the Missouri Department of Natural Resources 2002 list of impaired waters under the Total Maximum Daily Load (**TMDL**) section 303(d) of the Federal Clean Water Act (Figure 2, light gray). This section of Troublesome Creek is 303(d) listed for excessive, but naturally occurring, manganese with a "Low" priority for study (2002 TMDL). Dissolved manganese was not sampled during this project. It is also separately 303(d) listed for excessive sediment from agriculture non-point sources with a "Medium" priority for study.

A biological assessment was conducted on Troublesome Creek, Marion County in the fall of 2004 and spring of 2005. Stream habitat assessments were conducted and channel morphology measurements were recorded for Troublesome Creek, South River, and South Fabius River. The study area included the listed reach of Troublesome Creek (Figure 2), which starts upstream approximately five miles from the confluence with the South Fabius River.

This study was coordinated by the Aquatic Bioassessment Unit of the MDNR, Environmental Services Program (**ESP**), Water Quality Monitoring Section (**WQMS**). Kenneth B. Lister, David Michaelson, and the staff of the Water Quality Monitoring Section conducted the study.

1.2 Purpose

Determine if the TMDL listed 303(d) study area of Troublesome Creek, Marion County is impaired.

1.3 Objectives

1) Assess the macroinvertebrate community integrity and water quality in Troublesome Creek, Marion County.

2) Assess the stream habitat quality of Troublesome Creek, Marion County.

1.4 Tasks

1) Conduct a biological assessment, including macroinvertebrate and water physicochemical analyses, for Troublesome Creek, Marion County.

2) Conduct a stream habitat assessment of Troublesome Creek, South River, and South Fabius River, Marion County.

3) Compare Troublesome Creek stations results to wadeable/perennial stream biological criteria.

4) Compare physicochemical water quality from upstream to downstream as well as with Water Quality Standards (MDNR 2000).

5) Collect and analyze channel measurements at Troublesome Creek for comparison with unchannelized stream measurements.

1.5 Null Hypotheses

Troublesome Creek will be similar to wadeable/perennial stream biological criteria from upstream to downstream and between test and control stations.

Water quality at Troublesome Creek, Marion County will be similar between all stations and acceptable with Water Quality Standards (MDNR 2000).

Stream habitat assessment will be similar between test stations, as well as with stream habitat control stations.

Channel measurements will be similar between Troublesome Creek stations and controls.

2.0 Methods and Analyses

The study area, station descriptions, Ecological Drainage Units (**EDUs**), and land use are identified. The study timing is outlined. A method for the stream habitat assessment is discussed. Biological assessment procedures, which include macroinvertebrate community and physicochemical water collection and analyses, are discussed.

2.1 Study Area and Station Descriptions

The Troublesome Creek study area was located entirely in Marion County (Table 1, Figure 1). Five stations were allotted for comparisons. Three of the stations on Troublesome Creek (test stations) were located within five miles of the confluence with the South Fabius River (Figure 2). South River and South Fabius River stations were each allotted one station, which were used for stream habitat assessment and channel measurement controls (control stations). These were located within 10 miles of the three Troublesome Creek stations.

Table 1
Location and Descriptive Information for Troublesome Creek, South River, and South Fabius River, Marion County 2004-2005

Stream-Station Number	Location-Section, Township, Range	Description	County
Troublesome Creek #3	SW ¼ sec. 14, T. 59 N., R. 07 W.	Upstream County Road 118	Marion
Troublesome Creek #2	NE ¼ sec. 23, T. 59 N., R. 07 W.	Downstream County Road 143	Marion
Troublesome Creek #1	NW ¼ sec. 24, T. 59 N., R. 07 W.	Upstream Bridge County Hwy A	Marion
South River #1 (SHAPP and channel measurements)	NW ¼ sec. 31, T. 58 N., R. 05 W.	Upstream County Road	Marion
South Fabius River #1 (SHAPP and channel measurements)	SW ¼ sec. 23, T. 59 N., R. 08 W.	Downstream MDC Dunn Ford CA	Marion

2.1.1 Ecological Drainage Unit

Troublesome Creek flows within the Plains/Mississippi Tributaries between the Des Moines and Missouri River Ecological Drainage Unit (**Plains/MS Tributaries EDU**) (Figure 1). All of the test and control stations were within the Plains/MS Tributaries EDU. Ecological Drainage Units are delineated drainage units that contain all streams and tributaries within an ecological area. Similar size streams within an EDU are expected to contain similar aquatic communities and stream habitat conditions. Comparisons of biological and physicochemical results, as well as stream habitat within the same EDU, should then be appropriate.

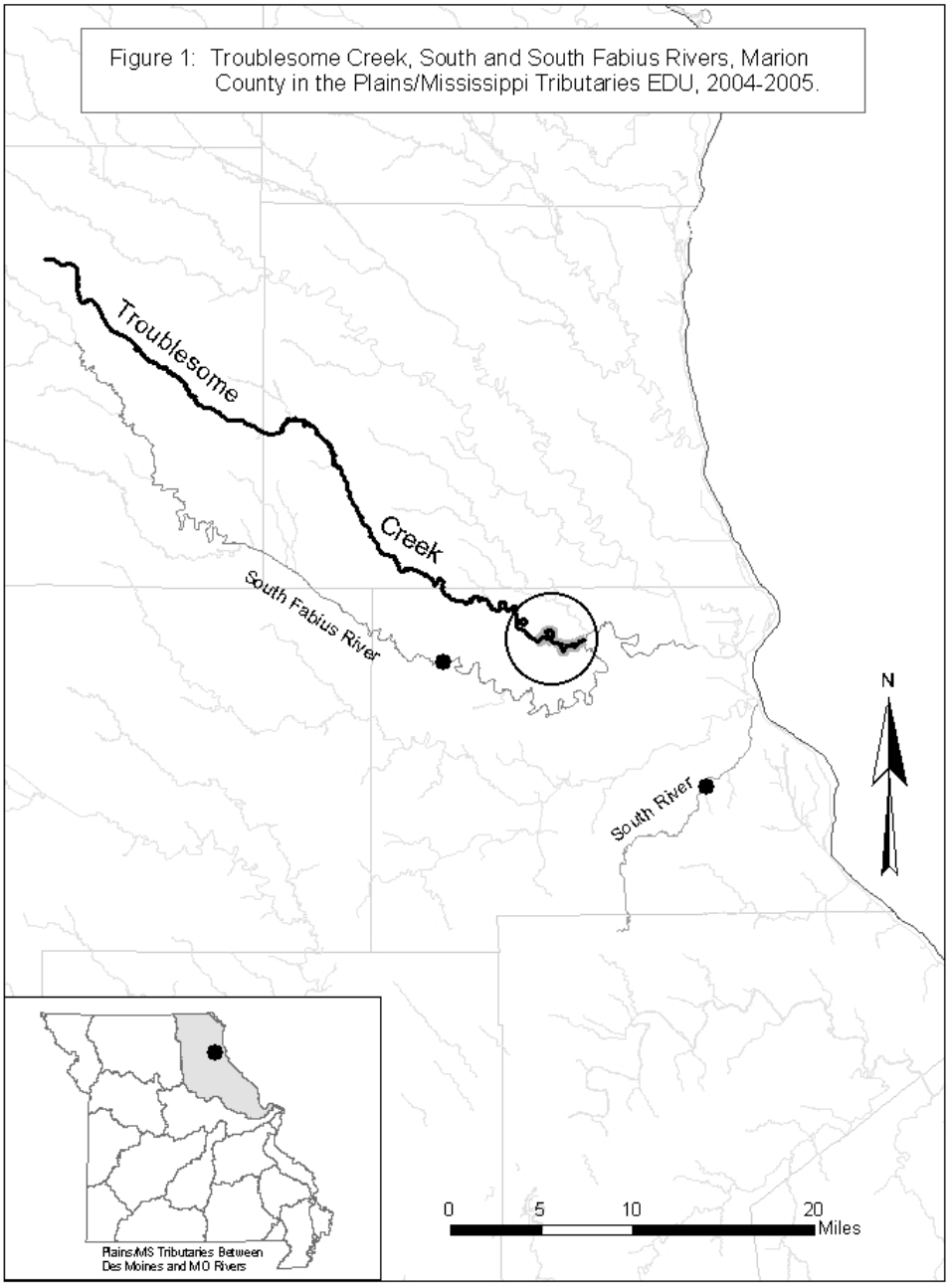
Figure 1: Troublesome Creek, South and South Fabius Rivers, Marion County in the Plains/Mississippi Tributaries EDU, 2004-2005.
Troublesome
Creek
South Fabius River
South River
N
0
5
10
20
Miles
Plains/MS Tributaries Between Des Moines and MO Rivers

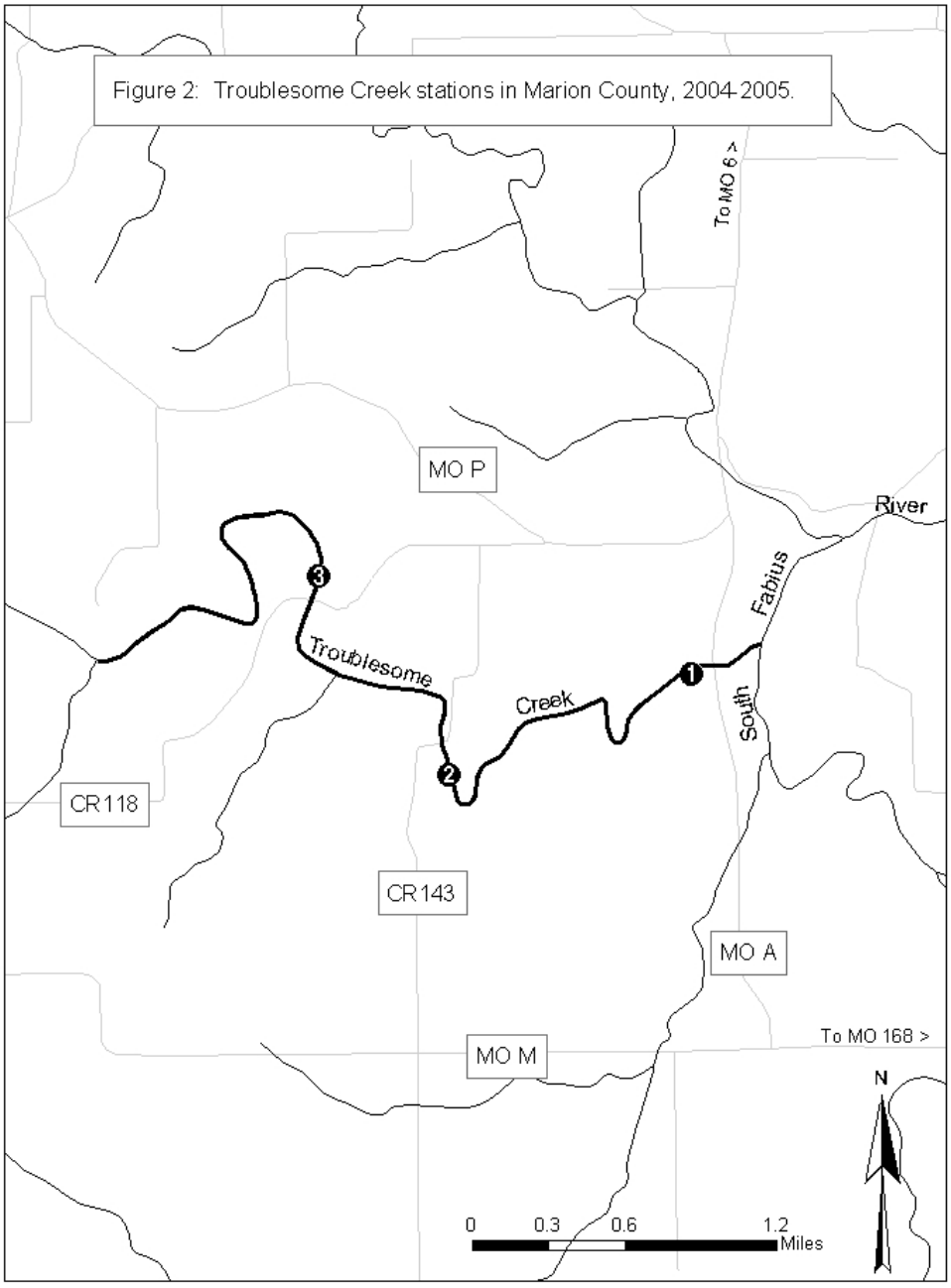
Figure 2: Troublesome Creek stations in Marion County, 2004-2005.
To MO 6 >
MO P
River
Fabius
South
Troublesome
Creek
1
2
3
CR118
CR143
MO A
MO M
To MO 168 >
N
0
0.3
0.6
1.2
Miles

2.1.2 Land Use Description

Land cover of the Plains/MS Tributaries EDU was compared to the 14-digit Hydrological Unit (**HUC-14**) land cover for each station (Table 2). Percent land cover data were derived from Thematic Mapper (TM) satellite data collected between 2000-2004 and interpreted by the Missouri Resource Assessment Partnership (**MoRAP**). The implication of this comparison is that land use is similar between all stations within the study and therefore does not interfere with interpretation of the findings.

Percent land cover in the Troublesome Creek HUC-14 was relatively similar to the controls and the Plains/MS EDU (Table 2). Troublesome Creek was dominated by grassland. South River and South Fabius River HUCs were similar to the Plains/MS Tributaries EDU in that crops dominated them all. In general, land-use was similar between all stations. Slight differences were not obviously influential enough to affect interpretation of the results.

Table 2
Percent Land Cover in the Troublesome Creek, South River, and
South Fabius River, Marion County Stations and the Plains/MS EDU

Stations	HUC-14	Urban	Crops	Grassland	Forest	Wetland / Open Water
Troublesome Creek #3, #2, #1	07110003030002	1	33	39	21	3
South River (SHAPP/Channel)	07110004030001	3	54	23	16	1
South Fabius River (SHAPP/Channel)	07110003020003	1	41	32	21	2
Plains/MS Tribs EDU	NA	3	42	29	19	--

2.2 Study Timing

This study took place in the fall of 2004 and the spring of 2005. Biological assessments and stream habitat assessments were conducted and channel measurements were recorded during these periods.

Biological assessments were conducted in the fall of 2004 and spring of 2005. Fall sampling was conducted at Troublesome Creek on September 21 and 22, 2004. Spring assessments were conducted at Troublesome Creek on April 5, 2005.

Stream habitat assessments were conducted in the fall of 2004. Troublesome Creek stream habitat assessments were conducted on September 23, 2004. Stream habitat assessments were conducted on South and South Fabius Rivers (controls) on October 5, 2004.

Channel measurements were recorded in the fall of 2004. Measurements at Troublesome Creek were recorded on September 23, 2004. Channel measurements were collected at South River and South Fabius River on October 5, 2004.

2.3 Stream Habitat Assessment

Stream habitat assessments were conducted at Troublesome Creek, South River, and South Fabius River as described in the standardized Stream Habitat Assessment Project Procedure (**SHAPP**) for "Riffle/Pool Prevalent" streams (MDNR 2003d). South and South Fabius Rivers served as stream habitat control stations (SHAPP controls). Assessment scores were compared between test stations and the SHAPP control stations. Scores were also compared to the mean score of the stream habitat control stations. According to the SHAPP, the quality of an aquatic community is based on the ability of a stream to support the aquatic community. If SHAPP scores at test stations were $\geq$75% of the mean of the SHAPP controls, the stream habitat at the test station was considered to have comparable stream habitat quality.

2.4 Biological Assessment

A biological assessment was conducted as described in MDNR's Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2003c). Biological assessments consist of macroinvertebrate community and physicochemical water collection and analyses of results from upstream to downstream, and between seasons. Macroinvertebrates and physicochemical water variables were analyzed for the three test stations in Troublesome Creek, Marion County.

2.4.1 Macroinvertebrate Sampling and Analyses

Macroinvertebrates were sampled from multiple habitats as described in the SMSBPP. Troublesome Creek is considered a riffle/pool dominant stream and habitats were sampled accordingly. Areas that were sampled included: flowing water over coarse substrate (**CS**), non-flowing water over depositional substrate (**NF**), and rootmat (**RM**) habitats.

Macroinvertebrate community data were analyzed using three strategies. Stream Condition Index (**SCI**) scores, individual biological criteria metrics, and dominant macroinvertebrate families (**DMF**) were examined and compared from upstream to downstream and between seasons. Individual taxa lists are found in Appendix A grouped by season from upstream to downstream.

A Stream Condition Index is a qualitative rank measurement of a stream's aquatic biological integrity (Rabeni et al. 1997). The SCI was further refined for reference streams within each EDU in Biological Criteria for Perennial/Wadeable Streams (**BIOREF**) (MDNR 2002).

The first analysis was of SCI scores by station and grouped by season. A station's SCI score is a compilation of rank scores given to the individual biological criteria metrics as a measure of biological integrity. Four primary metrics were used to calculate the SCI's

per station: 1) Taxa Richness (**TR**); 2) Ephemeroptera/Plecoptera/Trichoptera Taxa (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**). Individual metric (TR, EPTT, BI, SDI) scores were compared to the BIOREF scoring range (SCI Scoring Table, Tables 4 and 5) and rank scores (5, 3, 1) were assigned to each metric (Tables 4 and 5). Rank scores for all metrics were compiled for each station and their total SCI's were completed. The SCI scores are interpreted as follows: 20-16 = fully biologically supporting; 14-10 = partially biologically supporting; and 8-4 = non-supporting of the biological community.

Secondly, the individual biological criteria metrics (TR, EPTT, BI, SDI) were compared to the BIOREF scoring range to identify unusual responses or interesting trends at each station. Variations in metrics may help identify the type and source of impairment.

The third biological analysis was an evaluation of the DMF per station as a percentage of the total number of individuals in the sample. The eight (8) dominant families were listed for each station and grouped by season. Dominance by certain families may also help identify the type and source of impairment.

2.4.2 Physicochemical Water Sampling and Analyses

Physicochemical water samples were handled according to their appropriate MDNR, ESP Standard Operating Procedure (**SOP**) and/or Project Procedure (**PP**) for sampling and analyzing physicochemical water samples.

Fall 2003 and spring 2004 physicochemical water variables consisted of field measurements and grab samples that were returned to the ESP state environmental laboratory. Temperature, pH, conductivity, dissolved oxygen, and discharge were measured in the field. The ESP, Chemical Analysis Section (**CAS**) in Jefferson City, Missouri conducted water sample analyses for ammonia-nitrogen, nitrate + nitrite-nitrogen, Total Kjeldahl Nitrogen (**TKN**), chloride, and total phosphorus. Turbidity was measured and recorded in the WQMS biology laboratory.

Water samples were collected according to SOP MDNR-FSS-001 Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2003b). Samples were collected and kept on ice for transport to the ESP.

Physicochemical water variable analyses were compared between stations from upstream to downstream as well as with acceptable limits according to Missouri's Water Quality Standards (**WQS**) (MDNR 2000). Interpretation of acceptable limits within the WQS may be dependent on a stream's classification and its beneficial-use designation (MDNR 2000). The study area on Troublesome Creek is considered a class "P" stream, with designated uses for livestock and wildlife watering (LWW), protection of warm water aquatic life and human health-fish consumption (AQL), and drinking water supply (DWS) (MDNR 2000). Furthermore, acceptable limits for some variables may be dependent on the rate of exposure. These exposure or toxicity limits are based on the

lethality of a toxicant given long (chronic toxicity, **c**) or short-term exposure (acute toxicity, **a**). Results are reported for physicochemical water variables by station and season.

2.4.2.1 Discharge

Stream flow was measured using a Marsh-McBirney Flowmate™ flow meter at each station. Velocity and depth measurements were recorded at each station according to SOP MDNR-WQMS-113 Flow Measurement in Open Channels (MDNR 2003a).

2.5 Channel Measurements

Channel measurements were recorded to illustrate the size and shape of the stream and potentially identify channelization. These measurements included channel width, wetted width, and depth measurements in the channel. Channel measurements were recorded at ten transects per station. Channel width (CW) included the full channel measured at the top of the lower bank. Wetted width (WW) included the channel width that contained water. The depth of the stream was measured at three locations (1/4, 1/2, 3/4 of the wetted width) in each transect. Stream length was the length of the reach used in this study, which is approximately 20 times the average channel width that included at least two riffle sequences (MDNR 2003c).

Sinuosity is a ratio of the actual distance per straight-line (aerial) distance between two points that are approximately two miles apart, with the sampling point at the center.

2.6 Quality Control

Quality control was conducted according to MDNR Standard Operating Procedures and Project Procedures.

3.0 Results and Analyses

Results and analyses are compiled for stream habitat assessments, biological assessments, physicochemical water variables, and channel measurements. Results were compared from upstream to downstream test stations and between test and control stations where applicable.

3.1 Stream Habitat Assessments

Stream habitat assessments (SHAPPs) were conducted for all test stations and two control stations (SHAPP controls) in the fall of 2004 (Table 3). South and South Fabius Rivers served as the SHAPP controls. Stream habitat assessment (SHAPP) scores were similar between test stations (#3-145; #2-142; #1-147) with an average of 145. The SHAPP control scores (SR#1-132; SFR#1-140) were slightly lower than the test stations with an average of 136.

Table 3
Stream Habitat Assessment Scores and Percent Comparison for Troublesome Creek, Marion County, South River, and South Fabius River (SHAPP controls), Fall 2004

	Troublesome Creek #3	Troublesome Creek #2	Troublesome Creek #1	South River (SHAPP control)	South Fabius River (SHAPP control)
SHAPP Scores	145	142	147	140	132
Percent of Mean SHAPP Controls (136)	106	104	108	--	--

3.2 Biological Assessment

Biological assessment consisted of macroinvertebrate community analyses and physicochemical water quality comparisons between SCI scores, biological support categories, and individual metric scores (Table 4).

3.2.1 Macroinvertebrate Community Analyses

Macroinvertebrate analyses included examination of overall SCI scores, individual metric scores, and the DMF composition. Results were compared from upstream to downstream. These examinations may identify and illustrate impairment, as well as potentially identify a source.

3.2.1.1 Stream Condition Index Scores and Individual Biological Criteria Metrics

Macroinvertebrate community analyses consisted of comparisons of the stations using biological criteria (SCI and the scoring range for individual metrics). All comparisons and observations were made by season.

The Stream Condition Index (SCI) scores and the biological support category were similar between test stations and of high quality in the fall (Table 4). All test stations had SCI scores of 18 (#3 and #1) or 20 (#2). All were considered to be in the "Full" biological support category in the fall 2004 season (Table 4).

Individual metric scores contributed to lower SCI scores within each station in the fall (Table 4). Station #3 score was lower due to a BI (6.71) that was higher than the biological criteria optimal value (<6.34). Downstream stations (#2-6.25 and #1-6.13) were within the optimum range. All of the individual metrics at station #2 were within the optimum BIOREF scoring range. Station #1 had a slightly lower TR (70) than the biological criteria optimal value (>76) and from the TR values upstream (#3-85; #2-88). Individual metric scores followed no distinct pattern from upstream to downstream in the fall (Table 4).

Table 4
Fall 2004 Biological Criteria (BIOREF) Metric Scores, Biological Support Category, and Stream Condition Index (SCI) Scores for Troublesome Creek Stations, Marion County

Stream and Station Number	Sample No.	TR	EPTT	BI	SDI	SCI	Biological Support Category
Troublesome Creek #3	0418730	85	22	**6.71**	3.09	18	Full
Troublesome Creek #2	0418729	88	22	6.25	3.34	20	Full
Troublesome Creek #1	0418728	**70**	20	6.13	3.16	18	Full
BIOREF Score=5	--	>76	>18	<6.34	>3.00	20-16	Full
BIOREF Score=3	--	76-38	18-9	6.34-8.17	3.00-1.50	14-10	Partial
BIOREF Score=1	--	<38	<9	>8.17	<1.50	8-4	Non

SCI Scoring Table (in light gray) developed from BIOREF streams (n=8).

The SCIs fluctuated from upstream to downstream stations in the spring (Table 5). Station #3 was considered to be in the full biological support category, with a score of 16. Both station #2 and station #1 scores decreased to 14, which places them in the partial biological support category. Individual metric scores contributed to lower SCI scores with each station having biological criteria values that were less than optimum in the spring (Table 5). The score at station #3 was lower in EPTT (14), with a slightly higher (6.57) than optimum BI (<6.27). Station #2 had a lower score in TR (77), EPTT (13), and BI (6.50). Station #1 scored lower in TR (76), EPTT (16), and BI (6.48).

Table 5
Spring 2005 Biological Criteria (BIOREF) Metric Scores, Biological Support Category, and Stream Condition Index (SCI) Scores for Troublesome Creek Stations, Marion County

Stream and Station Number	Sample No.	TR	EPTT	BI	SDI	SCI	Biological Support Category
Troublesome Creek #3	0503022	79	**14**	**6.57**	3.23	16	Full
Troublesome Creek #2	0503021	**77**	**13**	**6.50**	3.31	**14**	Partial
Troublesome Creek #1	0503020	**76**	**16**	**6.48**	3.28	**14**	Partial
BIOREF Score=5	--	>78	>17	<6.27	>3.19	20-16	Full
BIOREF Score=3	--	78-39	17-8	6.27-8.14	3.19-1.60	14-10	Partial
BIOREF Score=1	--	<39	<8	>8.14	<1.60	8-4	Non

SCI Scoring Table (in light gray) developed from BIOREF streams (n=5).

There were no outstanding patterns or differences between the individual metrics from upstream to downstream in the spring (Table 5). The TR lowered by three taxa from upstream to downstream (#3-79; #2-77; #1-76). The EPTT varied slightly, but was similar from upstream to downstream (#3-14; #2-13; #1-16). The BI decreased slightly from upstream to downstream (#3-6.57; #2-6.50; #1-6.48).

3.2.1.2 Dominant Macroinvertebrate Families

Several trends were evident in the DMFs in the fall of 2004 (Table 6). Tubificidae was one of the dominant taxa (#3-17.0; #2-4.3; #1- 4.4). Chironomidae was included in the DMF (#3-15.5; #2-29.6; #1-25.0). Hepatgeniid and Baetid mayflies were also among the dominant macroinvertebrate families.

Table 6
Dominant Macroinvertebrate Families (DMF) as a Percentage of the Total Number of Individuals per Station, Fall 2004

Station	Troublesome Creek #3	Troublesome Creek #2	Troublesome Creek #1
Sample Number	0418730	0418729	0418728
Elmidae	18.8	19.5	26.8
Tubificidae	**17.0**	**4.3**	**4.4**
Chironomidae	**15.5**	**29.6**	**25.0**
Hydropsychidae	15.2	15.1	7.0
Heptageniidae	12.9	4.8	9.2
Baetidae	5.6	5.2	5.9
Caenidae	3.6	--	8.5
Coenagrionidae	2.3	--	--
Simuliidae	--	5.2	4.4
Leptohyphidae	--	5.0	--

Several trends were noted in the DMF percentages in the spring (Table 6). Chironomidae was the most dominant macroinvertebrate family (#3-45.6; #2-44.4; #1-54.0). Tubificidae was prevalent as well (#3-15.6; #2-10.0; #1-9.1). Perlidae stoneflies were a dominant family in the macroinvertebrate community at station #3 (2.8). Heptageniid and baetid mayflies were among the dominant taxa as well.

Table 7
Dominant Macroinvertebrate Families (DMF) as a Percentage of the Total Number of Individuals per Station, Spring 2005

Station	Troublesome Creek #3	Troublesome Creek #2	Troublesome Creek #1
Sample Number	0503022	0503021	0503020
Chironomidae	**45.6**	**44.4**	**54.0**
Tubificidae	**15.6**	**10.0**	**9.1**
Elmidae	11.6	15.2	13.9
Heptageniidae	7.2	4.5	5.7
Hydropsychidae	5.1	3.6	1.3
Caenidae	3.6	6.0	6.4
Perlidae	**2.8**	--	--
Baetidae	1.7	--	2.2
Simuliidae	--	5.2	1.5
Ceratopogonidae	--	2.1	--

3.2.2 Physicochemical Water Variables

Physicochemical water variables were notable from upstream to downstream and within each season.

Several physicochemical water variables were notable in the fall of 2004 (Table 8). Discharge increased slightly from upstream to downstream (#3-7.29; #2-9.31; #1-12.1). Turbidity was similar from upstream and decreased downstream (#3-25.1; #2-22.6; #1-21.5). Nutrients (TKN and total phosphorus), as well as chloride, were detected at all stations in the fall.

Table 8
Physicochemical Water Variables Per Station, Troublesome Creek for Fall 2004

Station Variable/Date	Troublesome Creek #3 9-22-04	Troublesome Creek #2 9-22-04	Troublesome Creek #1 9-21-04
Sample Number	0411665	0411664	0411663
pH (Units)	8.10	8.14	8.25
Temperature (C^0)	20.0	19.5	20.0
Conductivity (uS)	290	295	292
Dissolved O_2	8.32	9.76	9.62
Discharge (cfs)	7.29	9.31	12.1
Turbidity (NTUs)	25.1	22.6	21.5
Nitrate+Nitrite-N	0.40	0.43	0.47
TKN	0.78	0.69	0.75
Ammonia-N	<0.03	<0.03	<0.03
Chloride	12.3	12.1	13.0
Total Phosphorus	0.13	0.14	0.12

(Units mg/L unless otherwise noted; **Bold**=Above WQS or trend)

Several physicochemical water variables were notable in the spring (Table 9). Discharge was similar between stations from upstream to downstream (#3-17.6; #2-17.9; #1-17.9 cfs). Nutrients such as TKN (#3-0.83; #2-0.96; #1-0.71 mg/L) and total phosphorus (#3-0.06; #2-0.04; #1-0.05 mg/L) were detected at all stations. Chloride was detected and was similar from upstream to downstream (#3-17.3; #2-17.2; #1-17.5 mg/L).

Table 9
Physicochemical Water Variables Per Station, Troublesome Creek for Spring 2005

Station Variable/ Date	Troublesome Creek #3 4-5-05	Troublesome Creek #2 4-5-05	Troublesome Creek #1 4-5-05
Sample Number	0502955	0502954	0502953
pH (Units)	8.60	8.50	8.30
Temperature (C^0)	15.5	15.0	14.5
Conductivity (uS)	373	378	380
Dissolved O_2	11.8	10.9	8.95
Discharge (cfs)	17.6	17.9	17.9
Turbidity (NTUs)	6.38	5.43	5.39
Nitrate+Nitrite-N	<0.01	<0.01	<0.02
TKN	0.83	0.96	0.71
Ammonia-N	<0.03	<0.03	<0.03
Chloride	17.3	17.2	17.5
Total Phosphorus	0.06	0.04	0.05

(Units mg/L unless otherwise noted; **Bold**=Above WQS or trend)

3.2.3 Channel Measurements

Channel measurements were recorded at test stations on Troublesome Creek (T3, T2, T1) and compared with the two SHAPP control stations, South River (SR1) and South Fabius River (SFR1) (Table 10). Channel width (CW), wetted width (WW), depth, maximum depth, standard deviation of depth (S.D. of Depth), sinuosity (actual distance/straight-line distance ratio), and stream length were generally similar between the test stations (T3, T2, T1) and the channel measurement control stations on South River (SR1) and South Fabius River (SFR1).

Table 10
Channel Measurements for Troublesome Creek Stations (T3,T2,T1), South River (SR1), and South Fabius River (SFR1). Mean of measures unless otherwise noted: Feet (‘)

	CW	WW	CW/WW	DEPTH	MAX DEPTH	S.D. OF DEPTH	SINUOSITY (actual/straight-line)	STREAM LENGTH
T3	58.7	39.5	1.49	0.81	1.97	0.45	1.47	3098
T2	67	54.7	1.22	1.44	2.75	0.59	1.60	3207
T1	57.1	54.4	1.05	1.38	2.08	0.37	2.17	3256
SR1	78.9	39.3	2.01	0.92	2.75	0.74	1.39	3205
SFR1	54.5	33.6	1.62	1.22	3.17	0.66	1.26	3282

4.0 Discussion

The discussion includes evaluation of the stream habitat assessment, biological assessment (macroinvertebrate and water quality), and channel measurements. Trends were examined from upstream to downstream and between seasons, if necessary.

4.1 Stream Habitat Assessment

Stream habitat at Troublesome Creek stations was of slightly higher quality than the SHAPP controls at South River #1 or South Fabius River #1. All SHAPP scores at Troublesome Creek were higher than the SHAPP control stations. This implies that Troublesome Creek stream habitat was of good quality and that any impairment of test stations was probably not due to the quality or quantity of good stream habitat. The Troublesome Creek study area could be used as a SHAPP control for comparison with other riffle/pool streams in the Plains/Mississippi Tributaries EDU.

4.2 Biological Assessment

Biological assessments consist of macroinvertebrate community analyses and physicochemical water quality analyses in two seasons. Macroinvertebrate data suggest three things happened during our sampling. First, fall anomalies were observed in two of the individual metrics; second, two stations were found to be impaired in the spring; third, a seasonal difference in SCI and individual metric scores was observed.

4.2.1 Fall

In the fall, all stations were found to be in the full biological support category. However, two anomalies were observed in the macroinvertebrate integrity. A significant decrease was observed in the TR at station #1 when compared to the upstream stations and the BI was higher than the optimum biological criteria value at station #3.

4.2.1.1 Taxa Richness (TR)

In the fall, the TR at station #1 (70) from upstream (#3-85; #2-88) decreased by about 20 percent. Even though all other metrics at station #1 were within the biological criteria optimum scoring range, the decrease in TR suggested that the macroinvertebrate community was different at #1. However the BI at station #1 did not identify replacement with more organic tolerant taxa. Appendix A illustrates changes in the TR metric that caused the BI to decrease at station #1. The number of dipteran taxa decreased by 9 from station #2 to station #1. Other “worm” taxa were not found in station #1, as well. The decrease in dipterans and worms in station #1 illustrated that the decreased TR metric did not identify a problem in the macroinvertebrate community. The reason for the lower number of tolerant taxa (dipterans) was not identified.

4.2.1.2 Biological Index (BI)

The BI at station #3 was less than optimal in the fall. The higher BI at station #3 may have been a result of organic input upstream, as the BI is an indicator of organic pollution. The DMFs identified tubificids as being dominant at station #3 and decreasing downstream. The presence of tolerant tubificids and intolerant heptageniid and baetid mayflies suggests that an influence was present, but that it did not significantly alter the

community. The BI was also lower downstream in #2 and #1, which suggested there was either recovery or the influence had not reached downstream at that point in the fall

4.2.2 Spring

The macroinvertebrate community was slightly different from upstream to downstream in the spring. Stations #2 and #1 were found to be slightly impaired in the spring.

4.2.2.1 Impaired Stations

Two stations were impaired in the spring. Stations #2 and #1 were slightly below the optimum stream condition index (SCI). Several individual metrics illustrated that the macroinvertebrate community included fewer sensitive taxa, which were more tolerant to organic pollution, although diverse and evenly distributed. Stations #2 and #1 individual metric scores were close to the optimum BIOREF scoring range and to being considered in the full biological support category. Conversely, station #3 was in the full biological support category, however by a small margin. Only two taxa (TR) kept station #3 from being considered impaired.

The higher than optimum BI at all stations in the spring suggested that all stations were altered somewhat by organic pollution or disturbance. The fact that the BI was not as high at the downstream stations (#2 and #1) suggested that effects may have been diluted from upstream influences or that the numeric difference between the stations and the BIOREF scoring range was not significantly different. The lower BI at these stations in the fall suggested that the influence was not continuous and/or that a disturbance took place between fall 2004 and spring 2005 sampling.

4.2.3 Seasonal Difference

Seasonal SCI scores, individual metric scores, DMFs, and individual taxa illustrated a difference between the fall and spring macroinvertebrate communities.

4.2.3.1 SCI/Individual Metrics

The Troublesome Creek macroinvertebrate community was slightly different between spring and fall seasons, according to the SCI scores and individual metrics. All SCI scores were lower in the spring than in the fall. Individual metric scores explained the differences. The BI was generally higher in the spring than was found in the fall at all stations, except station #3, which indicated that the spring taxa were slightly more tolerant of organic pollution. The SDI was slightly higher in the spring than the fall at all stations except #2, suggesting that the community was more diverse and evenly distributed. The macroinvertebrate community was apparently more diverse and even in the spring, however, with fewer taxa and fewer sensitive taxa that were more tolerant of organic pollution than those found in the fall.

4.2.3.2 DMF/Individual Taxa

Chironomids and tubificid worms, which are generally more sediment and organic tolerant, were much more abundant as a percentage of the entire population of DMFs in the spring, as opposed to the fall. The chironomid abundance ranged from 45 to 54

percent in the spring; up from approximately 15 to 30 percent in the fall. Tubificids increased from 4 percent in the fall to approximately 10 percent at two downstream stations in the spring. The increase in the spring probably influenced the BI score and ultimately the SCI scores at #2 and #1.

Tubificid identification is normally more difficult in fall seasons due to the immaturity of identifiable characteristics. Potentially, several taxa may have been added to the spring bench sheet because they could be identified to a higher level. Subsequently, the BI increased, lowering the SCI and potentially creating the image of an impaired community. However, the increase in DMF tubificids suggests that the spring community was slightly more tolerant.

The data demonstrates a decrease in the number of potentially sensitive taxa and an increase in less sensitive taxa in the spring. Overall, Ephemeroptera decreased by as many as 8 taxa in the spring and by nearly half at all stations in the fall. Out of the remaining mayflies in the spring, only *Acerpenna sp*. and *Stenonema pulchellum* are considered to be sensitive mayflies. This supports the suggestion that increased organic contamination may have influenced the seasonal decline. However, the presence of several intolerant taxa (MDNR 2005b), including stonefly taxa *Amphinemura*, *Perlesta*, and/or *Hydroperla crosbyi* suggests that the impairment was not significant enough to eliminate all of the sensitive taxa, as described by DeWalt (et al. 2005).

4.3 Physicochemical Water Variables

Physicochemical water variables may support slight impairment through organic contamination. Discharge, channelization, and fine sediment were not obvious contributors.

4.3.1 Organics

Physicochemical water quality data did not support an obvious or sudden change in water quality. None of the water variables were observed at high levels in any of the grab samples. However, continuous low-level input of animal waste components may have influenced the integrity of the macroinvertebrate community.

Nutrients (TKN and total phosphorus) and chloride were detected, both of which are indicators of the presence of animal waste. TKN and chloride were found at low levels during both the fall and spring. Additionally, TKN and chloride were higher in the spring when discharge was slightly higher. Although animal waste components were found in low levels, constant input from upstream may have chronic effects on the spring aquatic community, as was evident by the increased BI, decreased TR, and slightly impaired condition at stations #2 and #1. Alternatively, a pulse of organic contaminants may have influenced the stream at any time, other than the time of sampling.

The SCS (1977) found a positive correlation with fecal coliform bacteria and organic nitrogen (TKN) load in Troublesome Creek approximately thirty-years ago and suggested that animal waste may have been the source. Local animal sources were not observed

near the stations, yet nearby land use was generally row cropping. The observation of affects at all stations suggested that the source(s) is/are upstream of the test area. One possible area of input may be a CAFO/large-scale cattle operation (Sharpe Land and Cattle Company) approximately 15 miles upstream. Other wastewater treatment facilities are found upstream that may have contributed to the slightly elevated nutrient levels as well. The potential source for the organic input should be identified and monitored.

4.3.2 Discharge

Discharge was approximately 50 percent greater in the spring (17cfs) than in the fall (9cfs), suggesting that increased discharge may have had a direct influence on the macroinvertebrate community through scour. However, precipitation records for Novelty, Knox County, Missouri in the headwaters of Troublesome Creek show little rain in the four months that preceded our spring sampling (http://agebb.missouri.edu/weather/history), which may have increased runoff or scour. It is not likely that discharge was great enough to scour the stream.

4.4 Channel Measurements

It is thought that channelized streams have less variation in depth and generally more homogenous habitat, which may not support a high quality macroinvertebrate community (AFS 1971). Channelized streams are straighter, wider, and shallower, with less variation of depth (MDNR 2005a). Troublesome Creek was comparable to the control streams. The study area was generally narrow and deeper than would be expected if the reach were channelized. Channelization was not a cause for impairment or seasonal differences.

This is consistent with previous findings in Troublesome Creek. Channelization within Troublesome Creek has been minimal, affecting less than ten percent of the total stream channel length (SCS 1977). Most channelization is confined to bridge crossings, however, more extensive alterations have occurred within Troublesome Creek east of Edina, Missouri, far upstream from our study area.

4.5 Sediment

Excessive amounts of fine sediment were not observed in the study area. Fine sediment intolerant Heptageniidae (Zweig and Rabeni 2001) were among the dominant taxa at all stations in both seasons. However, the stream quality upstream from the study area may be influenced by excessive fine sediment on the substrate (SCS 1977). Areas upstream were said to contain unstable fine sediment/sand substrates (SCS 1977). Clay loess, glacial-till soils, and intermittent vegetated riparian corridors may be contributors of the dominant substrate materials found in streams. The biological integrity and quantity of fine sediment should be studied upstream in Troublesome Creek to determine if it is impaired.

4.6 Manganese

The study area in Troublesome Creek is 303(d) listed for excessive manganese with a "Low" priority for study. Manganese was not included as a variable in this project, because excessive concentrations are a relative concern in drinking water or groundwater use designations (MDNR 2002). Manganese is not known to have an effect on macroinvertebrate communities at excessive concentrations. Manganese concentrations may be studied in the future at Troublesome Creek to determine if concentrations warrant 303(d) listing.

5.0 Conclusion

The goal of this study was to determine if Troublesome Creek, Marion County was impaired in the study area. The quality of macroinvertebrate community composition was impaired (partial biological support category) in station #2 and #1 during the spring sampling. The spring metrics indicated that the community TR was reduced and more tolerant of organic pollution than biological criteria streams. A seasonal difference was observed through the metrics. Nutrients and chloride were detected at all stations in low levels during both seasons, which indicated the presence of a continuous influence upstream from the test area. These water chemistry variables also increased in the spring with increased discharge when the community at station #2 and #1 were impaired. This continuous input may have affected the macroinvertebrate community and lowered the biological integrity of the stream. However, single grab water samples did not detect chemical variables at high levels, although pulses may have affected the macroinvertebrate community integrity.

The objectives were met. The macroinvertebrate community integrity, habitat quality, and water quality in Troublesome Creek, Marion County were assessed.

The hypotheses were addressed. Macroinvertebrate communities were similar to biological criteria reference streams and similar between stations in the fall of 2004. In the spring of 2005, the macroinvertebrate communities were of lower quality than biological criteria reference streams. Water quality was found to be similar from upstream to downstream and between seasons, with continuous low-level input of nutrients and chloride. The stream habitat at Troublesome Creek, Marion County was similar to the SHAPP controls. The stream morphology showed that Troublesome Creek stations were similar between stations, as well as similar to control stations, and the stream was not channelized.

6.0 Recommendations

1) Regard this study area as a possible stream habitat control (SHAPP control) for riffle/pool streams (MNDR 2003d) in the Plains/Mississippi Tributaries between Des Moines and Missouri Rivers EDU.

2) Periodically monitor macroinvertebrate community and water quality.

3) Identify and monitor the source for organic loading.

4) Conduct biological assessments upstream from this study area.

5) Conduct a fine sediment study within and upstream of the study area.

6) Study manganese concentrations to determine if concentrations warrant 303(d) listing.

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Appendix A

Troublesome Creek Macroinvertebrate Bench Sheet Reports
Fall 2004 and Spring 2005

(CS=coarse substrate, NF=non-flow, RM=rootmat habitats; -99=present)

Aquid Invertebrate Database Bench Sheet Report
Troublesome Ck [0418730], Station #3, Sample Date: 9/22/2004 6:30:00 PM

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	1	1	
AMPHIPODA			
Hyalella azteca			11
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		-99
BRANCHIOBDELLIDA			
Branchiobdellida	3		
COLEOPTERA			
Berosus			3
Dubiraphia	6	31	141
Helichus basalis			1
Helichus lithophilus			5
Hydroporus			2
Macronychus glabratus			6
Scirtes			1
Stenelmis	17	7	24
DECAPODA			
Orconectes luteus	-99	-99	-99
DIPTERA			
Ablabesmyia		17	3
Ceratopogoninae	1	1	
Cladotanytarsus	7	8	
Corynoneura		1	1
Cricotopus bicinctus	1		
Cricotopus/Orthocladius	10		
Cryptochironomus		3	
Cryptotendipes		2	
Dicrotendipes		2	
Glyptotendipes			1
Harnischia		2	
Hemerodromia	1		
Labrundinia		6	1
Nanocladius	2		3
Nilotanypus	3		
Paralauterborniella		1	
Paratanytarsus			2
Phaenopsectra		2	
Pilaria			1
Polypedilum convictum grp	37		
Polypedilum illinoense grp	1	7	7
Polypedilum scalaenum grp		1	

ORDER: TAXA	CS	NF	RM
Rheotanytarsus	27		
Saetheria	1		
Simulium	8		
Stempellinella		1	
Stictochironomus		1	
Tabanus	-99	1	
Tanytarsus	5	14	
Thienemanniella	5		
Thienemannimyia grp.	3		4
Tipula			1
EPHEMEROPTERA			
Acentrella	1		1
Acerpenna	2		
Baetis	9		
Brachycercus		3	
Caenis hilaris	2		
Caenis latipennis	5	17	18
Heptageniidae	38		
Hexagenia limbata		4	
Isonychia	1		
Leptophlebiidae		1	1
Procloeon		55	2
Stenacron	33	28	7
Stenonema femoratum		7	
Stenonema pulchellum	47		
Tricorythodes	23	1	
HEMIPTERA			
Corixidae		1	
Gerridae			-99
LIMNOPHILA			
Ancylidae	1		
Menetus			1
MEGALOPTERA			
Sialis		1	1
MESOGASTROPODA			
Hydrobiidae	1	1	2
ODONATA			
Argia	-99	2	8
Basiaeschna janata			-99
Enallagma			19
Gomphus			-99
Nasiaeschna pentacantha			-99
Progomphus obscurus		1	

ORDER: TAXA	CS	NF	RM
Tetragoneuria			-99
TRICHOPTERA			
Cheumatopsyche	183		
Chimarra	4		
Hydropsyche	5		
Nectopsyche		1	
Nyctiophylax		1	1
Phryganeidae			1
Triaenodes			1
TRICLADIDA			
Planariidae			5
TUBIFICIDA			
Branchiura sowerbyi	1	2	1
Limnodrilus cervix		1	
Tubificidae	73	101	31
VENEROIDEA			
Sphaeriidae	2	2	7

Aquid Invertebrate Database Bench Sheet Report
Troublesome Ck [0418729], Station #2, Sample Date: 9/22/2004 4:30:00 PM

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		1	4
AMPHIPODA			
Hyalella azteca			8
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	1	
COLEOPTERA			
Berosus			1
Dubiraphia	2	50	129
Helichus lithophilus			1
Hydroporus			1
Macronychus glabratus	1	1	2
Scirtes			4
Stenelmis	36	1	9
DECAPODA			
Orconectes luteus	1		-99
DIPTERA			
Ablabesmyia	2	32	3
Ceratopogoninae		2	1
Chironomus		3	
Cladotanytarsus	2	1	
Corynoneura	1		
Cricotopus bicinctus	9	2	
Cricotopus/Orthocladius	15	5	
Cryptochironomus	1	4	
Cryptotendipes		1	
Culicidae			1
Dicrotendipes	1	1	
Erioptera		1	
Glyptotendipes			1
Harnischia			1
Labrundinia		5	3
Nanocladius		1	1
Nilotanypus	2		
Parachironomus			1
Paracladopelma		1	
Parakiefferiella	2	10	1
Paralauterborniella		4	
Paratanytarsus		2	1
Phaenopsectra		2	
Polypedilum	2		3
Polypedilum convictum grp	90	3	

ORDER: TAXA	CS	NF	RM
Polypedilum halterale grp	1	2	
Polypedilum illinoense grp	8	4	4
Procladius		3	
Prosimulium	15		
Rheocricotopus	2		
Rheotanytarsus	22		1
Saetheria	1		
Simulium	47		
Stempellinella		7	
Stictochironomus		2	
Tanytarsus	9	27	8
Thienemanniella	13	2	
Thienemannimyia grp.	7		4
Tribelos		2	2
EPHEMEROPTERA			
Acentrella	4		
Acerpenna	12		
Baetis	23		
Brachycercus		1	
Caenidae	2	4	
Caenis latipennis			38
Callibaetis		1	
Hexagenia		2	
Isonychia	1		
Leptophlebiidae			3
Procloeon		19	3
Stenacron	3	2	14
Stenonema	25	2	
Stenonema pulchellum	10		1
Tricorythodes	59		
HEMIPTERA			
Belostoma			-99
Gerridae			1
Neoplea			1
LUMBRICINA			
Lumbricidae	1		-99
MEGALOPTERA			
Sialis			-99
MESOGASTROPODA			
Hydrobiidae		3	1
ODONATA			
Argia			7
Basiaeschna janata			-99
Calopteryx			1

ORDER: TAXA	CS	NF	RM
Enallagma			18
Nasiaeschna pentacantha			-99
TRICHOPTERA			
Cernotina			1
Cheumatopsyche	170		1
Chimarra	2		
Hydropsyche	8		
Hydroptila	1		
Nectopsyche		1	4
Polycentropodidae		1	
TRICLADIDA			
Planariidae		1	2
TUBIFICIDA			
Branchiura sowerbyi		3	
Enchytraeidae	1		
Tubificidae	12	34	2
VENEROIDEA			
Sphaeriidae	2		1

Aquid Invertebrate Database Bench Sheet Report
Troublesome Ck [0418728], Station #1, Sample Date: 9/21/2004 3:45:00 PM

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		1	2
AMPHIPODA			
Hyalella azteca			3
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		-99
COLEOPTERA			
Berosus			1
Dubiraphia	1	29	127
Hydroporus		1	
Macronychus glabratus			1
Stenelmis	93	20	51
DECAPODA			
Orconectes luteus	2	6	-99
DIPTERA			
Ablabesmyia	3	27	3
Ceratopogoninae		1	1
Cladotanytarsus	22	4	
Corynoneura	5	3	1
Cricotopus bicinctus	1		
Cricotopus/Orthocladius	12	2	
Cryptochironomus	2	3	
Dicrotendipes	1	1	
Harnischia		1	
Hemerodromia	1		
Labrundinia	5	2	
Microtendipes	1	1	
Nanocladius			1
Nilotanypus		4	
Paracladopelma		1	
Parakiefferiella	2	9	1
Phaenopsectra		2	
Polypedilum convictum grp	87		1
Polypedilum halterale grp		4	
Polypedilum illinoense grp	1	3	4
Procladius		3	
Rheotanytarsus	12		1
Saetheria	1		
Simulium	53		
Stempellinella		1	
Stictochironomus		2	
Tanytarsus	8	22	5

ORDER: TAXA	CS	NF	RM
Thienemanniella	4	1	2
Thienemannimyia grp.	9	4	5
Tipula			-99
EPHEMEROPTERA			
Acentrella	2		
Acerpenna	9		
Baetis	46		
Caenis latipennis	8	39	56
Heptageniidae	4		
Isonychia	1		
Leptophlebiidae			2
Leucrocuta	1		
Procloeon		13	1
Stenacron	25	38	4
Stenonema femoratum	3	5	
Stenonema pulchellum	30		1
Tricorythodes	36		1
HEMIPTERA			
Ranatra nigra			-99
LIMNOPHILA			
Ancylidae	1		
LUMBRICINA			
Lumbricidae		1	
MEGALOPTERA			
Sialis			-99
ODONATA			
Argia			3
Calopteryx			2
Enallagma			6
Macromia			1
TRICHOPTERA			
Cernotina		4	2
Cheumatopsyche	81		
Chimarra	11		
Hydropsyche	3		
Nectopsyche			1
Polycentropus		1	
Triaenodes			1
TUBIFICIDA			
Branchiura sowerbyi		4	
Tubificidae	29	16	4
VENEROIDEA			
Sphaeriidae	3	4	1

Aquid Invertebrate Database Bench Sheet Report
Troublesome Ck [0503022], Station #3, Sample Date: 4/5/2005 2:00:00 PM

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		1	
AMPHIPODA			
Crangonyx			-99
Hyalella azteca			1
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		-99
COLEOPTERA			
Berosus			2
Dubiraphia	1	11	84
Helichus lithophilus			6
Macronychus glabratus			6
Stenelmis	22	11	11
DECAPODA			
Orconectes immunis			-99
Orconectes luteus	1		-99
DIPTERA			
Ablabesmyia		12	10
Ceratopogoninae	1	6	
Cladotanytarsus	2	4	
Corynoneura	1	2	
Cricotopus/Orthocladius	180	5	5
Cryptochironomus	7	7	1
Cryptotendipes		2	
Dicrotendipes		1	
Eukiefferiella	5		
Harnischia		3	
Hydrobaenus	8	2	1
Labrundinia			5
Larsia	1		
Microtendipes			1
Nanocladius		2	13
Nilotanypus	1		
Orthocladius (Euorthocladius)	2		
Parachironomus			1
Parakiefferiella		1	
Paralauterborniella		6	1
Parametriocnemus	1		
Paratanytarsus		3	6
Paratendipes		1	
Polypedilum convictum grp	24	2	1
Polypedilum halterale grp		10	

ORDER: TAXA	CS	NF	RM
Polypedilum illinoense grp			2
Polypedilum scalaenum grp	1	6	1
Rheocricotopus	1		
Rheotanytarsus	35	1	
Saetheria	18		
Simulium	17		
Stempellinella			4
Stictochironomus	1	4	
Tabanus	-99		
Tanytarsus	20	29	30
Thienemanniella	8		1
Thienemannimyia grp.	43	1	23
Tribelos		1	1
Tvetenia bavarica grp	1		
EPHEMEROPTERA			
Acerpenna	22		
Caenis latipennis	7	11	28
Hexagenia limbata		1	
Stenacron	13	17	5
Stenonema femoratum	1	2	
Stenonema pulchellum	23		30
Tricorythodes	1		
HAPLOTAXIDA			
Haplotaxis		14	
HEMIPTERA			
Belostoma			-99
ODONATA			
Argia			2
Basiaeschna janata			-99
Calopteryx			-99
Enallagma			4
Somatochlora			-99
PLECOPTERA			
Hydroperla crosbyi	1		
Perlesta	36		
TRICHOPTERA			
Cernotina		1	
Cheumatopsyche	51	3	10
Nectopsyche			2
Nyctiophylax		1	
Oecetis	1		
TRICLADIDA			
Planariidae			1

ORDER: TAXA	CS	NF	RM
TUBIFICIDA			
Branchiura sowerbyi		1	1
Enchytraeidae	1	2	1
Limnodrilus cervix		5	
Limnodrilus claparedianus		5	
Limnodrilus hoffmeisteri	3	11	1
Tubificidae	53	114	2
VENEROIDEA			
Sphaeriidae	2	2	7

Aquid Invertebrate Database Bench Sheet Report
Troublesome Ck [0503021], Station #2, Sample Date: 4/5/2005 12:15:00 PM

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		1	
AMPHIPODA			
Hyalella azteca			4
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	1	-99
COLEOPTERA			
Berosus		1	
Dubiraphia	16	46	68
Helichus lithophilus	-99		3
Hydroporus			1
Macronychus glabratus			1
Scirtes			1
Stenelmis	38	8	10
DECAPODA			
Orconectes luteus	-99	-99	-99
DIPTERA			
Ablabesmyia	1	6	15
Ceratopogoninae	2	21	3
Cladotanytarsus	10	3	
Corynoneura		1	
Cricotopus bicinctus	2		2
Cricotopus/Orthocladius	128	5	10
Cryptochironomus	5	6	
Cryptotendipes		9	1
Dicrotendipes		1	
Diptera		1	
Eukiefferiella	16		
Harnischia		1	
Hydrobaenus	2	4	
Labrundinia			9
Nanocladius			10
Nilotanypus	4		1
Parachironomus			1
Paralauterborniella		12	
Paraphaenocladius			1
Paratanytarsus	2	1	12
Paratendipes		1	
Phaenopsectra		1	1
Polypedilum convictum grp	47		1
Polypedilum fallax grp		1	
Polypedilum halterale grp		9	

ORDER: TAXA	CS	NF	RM
Polypedilum illinoense grp	4		3
Polypedilum scalaenum grp	1	9	
Pseudochironomus		1	
Rheotanytarsus	17		4
Saetheria	2		
Simulium	62	2	
Stictochironomus		9	
Tabanus	-99		
Tanytarsus	15	43	51
Thienemanniella	1		1
Thienemannimyia grp.	5	1	37
Tipula	-99		
Tvetenia bavarica grp	1		
EPHEMEROPTERA			
Acerpenna	7		
Caenis latipennis		19	55
Hexagenia limbata		1	
Stenacron	10	7	9
Stenonema femoratum		3	2
Stenonema pulchellum	23		2
Tricorythodes	7		4
HEMIPTERA			
Belostoma			-99
MEGALOPTERA			
Sialis			1
ODONATA			
Argia		2	8
Basiaeschna janata			-99
Calopteryx			1
Enallagma			3
PLECOPTERA			
Amphinemura	3		
Hydroperla crosbyi	-99		
Perlesta	22		
TRICHOPTERA			
Cheumatopsyche	36	1	8
Hydroptila	1		
Nectopsyche			1
TRICLADIDA			
Planariidae	1		
TUBIFICIDA			
Branchiura sowerbyi		1	
Enchytraeidae	6	2	

ORDER: TAXA	CS	NF	RM
Ilyodrilus templetoni			1
Limnodrilus cervix		2	
Limnodrilus claparedianus		1	
Limnodrilus hoffmeisteri	3	8	2
Tubificidae	29	72	4
VENEROIDEA			
Sphaeriidae	17	8	-99

Aquid Invertebrate Database Bench Sheet Report
Troublesome Ck [0503020], Station #1, Sample Date: 4/5/2005 10:30:00 AM

ORDER: TAXA	CS	NF	RM
AMPHIPODA			
Crangonyx			-99
Hyalella azteca			3
ARHYNCHOBDELLIDA			
Erpobdellidae		-99	
COLEOPTERA			
Berosus		1	
Dubiraphia	3	25	43
Helichus lithophilus			5
Macronychus glabratus			5
Stenelmis	69	21	5
DECAPODA			
Orconectes luteus	-99		-99
DIPTERA			
Ablabesmyia		18	6
Ceratopogoninae		11	1
Cladotanytarsus	1	1	1
Clinocera		1	
Corynoneura	11		2
Cricotopus bicinctus	11	1	8
Cricotopus/Orthocladius	172	7	36
Cryptochironomus	11	5	
Cryptotendipes		2	
Diamesa	1		
Eukiefferiella	8		
Hydrobaenus	4	1	2
Labrundinia			8
Nanocladius		2	26
Natarsia		1	
Nilotanypus	2		3
Orthocladius (Euorthocladius)	1		
Paralauterborniella		15	1
Parametriocnemus	3		
Paratanytarsus	1	2	7
Paratendipes		11	1
Phaenopsectra		2	
Pilaria			-99
Polypedilum convictum grp	69		1
Polypedilum fallax grp	2		
Polypedilum halterale grp		1	
Polypedilum illinoense grp		2	2
Polypedilum scalaenum grp	2	3	

ORDER: TAXA	CS	NF	RM
Procladius		1	
Rheotanytarsus	2	1	5
Saetheria	15		
Simulium	17	2	
Stempellinella		2	1
Stictochironomus		12	
Tabanus		-99	
Tanytarsus	10	33	38
Thienemanniella	2	1	
Thienemannimyia grp.	24		32
Tribelos		6	
Tvetenia	1		
EPHEMEROPTERA			
Acerpenna	26		2
Caenis latipennis	4	19	56
Hexagenia limbata		1	
Leptophlebia			1
Stenacron	4	14	5
Stenonema femoratum	5	1	
Stenonema pulchellum	37	1	3
Tricorythodes	1		
LIMNOPHILA			
Ferrissia		1	
MEGALOPTERA			
Sialis		1	
ODONATA			
Argia			2
Calopteryx		-99	-99
Enallagma			6
PLECOPTERA			
Amphinemura	1		
Perlesta	15		
TRICHOPTERA			
Cernotina		1	
Cheumatopsyche	11		6
Chimarra	1		
Hydroptila		2	
Polycentropus			2
Triaenodes			1
TUBIFICIDA			
Enchytraeidae	1	3	1
Limnodrilus cervix	1	6	
Limnodrilus claparedianus	2	3	
Limnodrilus hoffmeisteri	5	9	

ORDER: TAXA	CS	NF	RM
Tubificidae	46	37	3
VENEROIDEA			
Sphaeriidae	2	2	